BY GARY GIUST, PHD

Setting up your oscilloscope to measure jitter

Half the battle in measuring jitter is simply setting up the oscilloscope. The goal here is to capture and display the signal as it would appear in its system environment. Because real-time oscilloscopes are workhorses in any laboratory, it's important to know how to get the most out of them. Jitter measurements are particularly sensitive to their environment. Consider some ways of optimizing this environment for measuring all types of jitter.

Begin by selecting an instrument with a proper bandwidth. If the bandwidth is too low, measured edge rates appear slow. Slower edge rates more efficiently convert amplitude noise into timing errors. An excessively high bandwidth, however, only raises the noise floor by increasing the thermal and shot noise in the measurement. A bandwidth of 1.8 times the bit rate is a good rule of thumb for NRZ (non-return-to-zero) data.

Next, set the sampling rate high enough to avoid aliasing effects from undersampling. In theory, the sampling rate must be at least twice the highest fundamental frequency in the signal. In practice, analog-signal-conditioning and data-conversion processes inherent in the acquisition use additional bandwidth, such that oscilloscopes realistically need a minimum sampling rate of 2.5 to three times this frequency. Oscilloscope manufacturers therefore ship instruments with bandwidth-to-sampling-rate ratios of approximately 1-to-3.

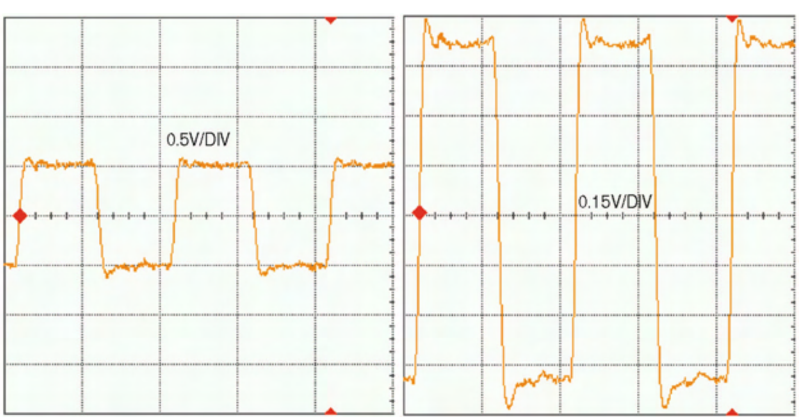
Maximizing the instrument's vertical resolution is critical for minimizing ADC quantization error. Adjust the volts-per-division knob until the image just fills the vertical height of the display. Overfilling the display saturates the ADC converter, whereas underfilling it reduces SNR (signal-to-noise ratio). **Figure 1** shows how this simple adjustment can dramatically improve measurement results.

The timebase setting is also important to consider when measuring TIE (time-interval-error) jitter, because this setting acts as an adjustable high-pass jitter filter. The timebase sets the lowest TIE frequency that the measurement captures. (The oscilloscope's bandwidth sets the highest jitter frequency.)

Also, make sure to test with data patterns containing a suitable range of frequency content. And, test using data patterns with realistic frequency content. When using PRBS (pseudo-random-bit-sequence) patterns, use pattern lengths long enough to capture low-frequency effects but short enough for the instrument's memory depth to fully capture them.

Always minimize the delay between the trigger and first sampled data point. After the signal is triggered, the timing uncertainty is proportional to how long the timebase waits before sampling the data. Reducing this delay minimizes this timing uncertainty, thereby lowering the measured jitter value.

Avoid oscilloscope modes that average the waveform, select sin(x)/x interpolation between data points, and use fast triggers with large amplitudes. Finally, set the trigger voltage to agree with the real system's receiver threshold voltage if you know it; otherwise, set it to the waveform's 50% level. EDN



Jitter	0.5V/div	0.15V/div	Reduction (%)
Time-interval error	59	39	34
Period jitter	75	41	45
Cycle-to-cycle jitter	137	72	48

Note: Measure jitter in peak-to-peak picoseconds.

Figure 1 Changing the vertical resolution for this 100-MHz 1V p-p signal from 0.5V/division (left) to 0.15V/division (right) dramatically improves the measured jitter by reducing ADC quantization errors.

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